The ADEPT Group, Inc.

Services at the interface of energy, economics and environment

1575 Westwood Blvd., Suite 200, Los Angeles, CA 90024 USA Telephone (310) 478-8448 Fax: (310) 478-5658

file:ARBrpt9906.doc
SCAQMD Contract No: 98108

August 9, 1999

ARB LPG Fuel Blends Evaluation Project
June 1999 Progress Report

submitted to:

LPG Fuel Blends Evaluation Project Task Group and Co-Sponsors

American Automobile Manufacturers Association, ARCO Products Co., California Air Resources Board, Cummins Engine Co., Engine Manufacturers Association, Equilon, Ford Motor Co., GFI, IMPCO, National Propane Gas Association, National Renewable Energy Laboratory, Natural Resources Canada, Propane Education and Research Council, Railroad Commission of Texas Alternative Fuels Research & Education Division, South Coast Air Quality Management District, Tosco Refining Co., and Western Propane Gas Association

---

I. Executive Summary

Medium and Light-duty emissions tests were completed in 1998. Performance/ Combustion tests were completed in January 1999 at Southwest Research Institute (SwRI). Bodycote ORTECH (Bodycote) conducted engine performance tests to prepare for Durability tests. Project fundraising and management continued.

II. Test Program Work Performed

A. Fuel Composition Tests

ADEPT received the fuel blend composition results from Dixie Services, Inc. (Dixie) on the LPG blend for Durability tests (attached). The results were within the tolerances previously agreed to and observed throughout the project. Table 1 provides a summary of the results.

ADEPT received amended laboratory reports from Maxxam Analytics Inc. (attached).

Other fuel composition data from the Emissions and Performance/Combustion tests can be accessed in prior monthly reports at ARB's website:
http://www.arb.ca.gov/altfuels/lpg/mvlpge/mvlpge.htm

Table 1: Dixie Fuel Blend Composition Matrix			
Components	4-June-99[1]	17-Jun-99[2]	Analysis (*Differences*)
	(vol. %)		
Methane	0.06	0.08	0.02
Ethane	3.96	4.20	0.24
Propane	80.87	81.32	0.45
Propylene	10.73	10.25	-0.48
Isobutane	0.72	0.69	-0.03
n-Butane	3.59	3.41	-0.18
t-2-Butene	0.03	0.03	0.00
Isopentane	0.03	0.02	-0.01
c-2-Butene	0.01	0.00	-0.01

B. Medium-Duty Engine (Cummins B5.9LPG) Emissions Tests at Bodycote

Tests were completed in August 1998. Final Report was submitted on November 18, 1998. Prior monthly reports and the Final Report can be accessed on ARB's website: http://www.arb.ca.gov/altfuels/lpg/mvlpge/mvlpge.htm.

C. Light-Duty Truck (F150 Bi-Fuel) Emissions Tests at ARB Haagen Smit Laboratory

Tests ended in September 1998. ARB's final report was requested.

D. Performance/Combustion Tests at SwRI

Tests were completed in January in 1999. The Final Report was sent to the Task Group. No written comments were received date.

Test program protocol and previous reports can be accessed at ARB's website: http://www.arb.ca.gov/altfuels/lpg/mvlpge/mvlpge.htm.

E. Durability Tests at Bodycote

Bodycote had trouble finding a starter motor for the engine. After attempts with new starters, Bodycote disassembled the driveshaft and flywheel. Cummins Engine Company (Cummins) and Cummins Ontario were given the parts' numbers to find a matching flywheel, flywheel housing, and starter motor. There was confusion as to whether the

[1] Durability fuel sample drawn from 14,000 USWG trailer at Primemax.
[2] Durability fuel sample drawn from 2,000 USWG tank at Bodycote.

test engine was "hand-made" or "production". The flywheel and starter motor from Cummins did not fit. The flywheel housing and starter were replaced. Finally, the engine started and ran satisfactorily.

Primemax delivered the LPG test fuel to Bodycote. The fuel supply system (fuel line, fuel pump, and flow meter system) was assembled. The test cell dynamometer and throttle controller were tuned. An engine torque curve indicated that the engine could not reach rated power. Per diagnosis, the fuel vaporizer (from GFI) and filter were replaced and the engine reached rated power (see attached performance curve). Engine performance tests measured engine parameters at the two stages in the durability test cycle; stage 1 at 60% rated power and stage 2 at rated power (attached).

The preliminary test from –10 to 0 hour at 60% rated power was conducted. Baseline engine measurements were made. The 0-hour oil sample and filter were sent to Hertz Engineering (Hertz).

Due to budgetary constraints caused by AFRED funding delays, ADEPT requested Bodycote to suspend Durability tests until July 6, 1999.

III. Project Management Support and Administrative Work Performed

A. Project Fundraising

Contrary to earlier expectations, on June 17, 1999, California Energy Commission (CEC) informed ADEPT that there was no money available for this project. The reason given for this change of position was the lower than expected funding given to CEC in the recently passed 2000 California State budget. The expected CEC contribution was $10,000.

The Texas Alternative Fuels Committee (TAFC) budget is under negotiation in the Appropriations Committee of the Texas legislature. This grant may be at risk during this process.

ARB informed ADEPT that it is likely to fund an additional $15,000.

B. Project Expenditures

Table 2 shows June expenditures and total expenditures to date.[3]

Table 2: June Expenditures and Total Expenditures to Date

Item	Funds Expended In June	Funds Expended to Date
Fuel (Air Liquide, Phillips)	$3,641.42	$30,217.43
Emissions Tests (Bodycote)	$0.00	$176,351.07[4]
Perf./Comb. Tests (SwRI)	$0.00	$83,794.97
Fuel Properties (Dixie)	$670.00	$12,958.46
Engine	$0.00	$17,063.47
Raw Durability Tests (Bodycote, Hertz)	$0.00	$19,000.00
Project Management	$1,832.12	$84,724.32[5]
Attorney Fees	$0.00	$2,250.00
Subcontractor	$440.00	$4,374.29
Miscellaneous	$0.00	$702.93
Total	**$6,583.54**	**$431,436.94**

Project Account Balance at month's end: **$5,160.65**

Table 3 shows total funds received to date, by respective funder.

Table 3: Total Funds Received to Date

Funder	Amount
ARB (ULTRAMAR)	$85,000.00
ARCO	$45,000.00
EMA	$1,000.00
NPGA	$8,920.00
NRCan	$119,500.95[6]
PERC	$25,000.00[7]
SCAQMD	$82,876.64
Shell/Equilon	$36,000.00
Tosco	$22,500.00
WPGA	$10,800.00
Total	**$436,597.59**

[3] All outlays above $1,000 are pre-approved by the LPG Task Group and/or the TAC.
[4] Total includes $23,422.55 (CAN$35,931.02), paid directly to Bodycote by PGAC.
[5] The amount listed for project management in the May 1999 Progress Report was short $5,500.00.
[6] Total of three payments: one at US$61,356.48 (conversion ratio of 0.6817), one at US$34,721.92 (conversion ratio of 0.6518), and one at US$23,422.55 (conversion ratio of 0.6519). This figure was incorrectly reported in prior monthly reports due to an ADEPT accounting error.
[7] Total PERC award was $30,000. $5,000 was allotted to PVC for its project costs.

Table 4 summarizes the in-kind services received to date, by respective funder.

Table 4: In-Kind Services Received to Date

Funder	Item	Estimated Value
ARB	ARB-El Monte Light-Duty Emissions Tests	$90,000
Cummins	Test Support	$8,000
Ford	Vehicle and Test Support	$23,500
NREL	Cummins B5.9LPG Engine	$15,000
	TOTAL	**$136,500**

C. Project Contracts and Other Documents

1. The final February, March, and April 1999 Progress Reports were distributed to the Task Group.

Travel associated with effort described:
No travel was conducted in June.

IV. Work planned for the next reporting period (July 1-31, 1999)

Project Management-ADEPT

1. Continue general project management.
2. Prepare and complete funding contracts for co-sponsors.
3. Continue fundraising.
4. Continue Durability tests.

Test Program

1. ARB-El Monte will finalize results and submit a draft Final Report.
2. Bodycote will continue durability tests.

V. Attachments:

1. Dixie fuel blend composition results;
2. Maxxam amended fuel blend composition results;
3. Bodycote's Engine Torque Curve;
4. Bodycote's Engine Performance Tests Results.

VI. Disclaimer

This report was prepared by ADEPT as result of work co-sponsored by the SCAQMD and Task Group members. Opinions, findings, conclusions, and recommendations within are those of the author and do not necessarily represent SCAQMD's views. SCAQMD, their officers, employees, contractors, and subcontractors make no warranty, expressed or implied, and assumes no legal liability for the information in this report. SCAQMD has not approved or disapproved this report, nor have they passed upon the accuracy or adequacy of the information contained herein.

VII. Glossary of Acronyms

AFRED	Alternative Fuels Research and Education Division
ARB	California Air Resources Board
ARB-El Monte	ARB Haagen Smit Laboratory in El Monte, CA
CEC	California Energy Commission
EMA	Engine Manufacturers Association
Hertz	Hertz Engineering Inc.
LPG	liquefied petroleum gases
NPGA	National Propane Gas Association
NRCan	Natural Resources Canada
NREL	National Renewable Energy Laboratory
Bodycote	Bodycote ORTECH
PGAC	Propane Gas Association of Canada
PERC	Propane Education and Research Council
PVC	Propane Vehicle Council
SCAQMD	South Coast Air Quality Management District
SwRI	Southwest Research Institute
TAC	Technical Assessment Committee
TAFC	Texas Alternative Fuels Commission
USWG	U.S. water gallons
WPGA	Western Propane Gas Association